

Implications of the PPLA Grading System on Stone Type and Pathogenesis

Blake Anderson M.D., Joshua Heiman M.S., Tim Large M.D., James C. Williams Ph.D., James E. Lingeman M.D.
Indiana University School of Medicine, Indianapolis, Indiana

Abstract

Introduction and Objective:

Prior research using the PPLA Grading System (PPLA) demonstrated the strong relationship between Randall's plaques and pitting. The aim of this study is to compare PPLA scores to stone analysis to determine if endoscopic findings can predict stone type and if any insights to stone pathogenesis can be established.

Methods:

From an IRB-approved, single institution prospective database, 56 kidneys had undergone renal papillary endoscopic mapping and PPLA grading from 2015-2016 at time of percutaneous nephrolithotomy. Interobserver and intraobserver reliability have been previously shown to be substantial for PPLA. Demographics and baseline characteristics were collected. Stone analysis was performed by Micro CT. Infection and uric acid stones were excluded. All possible pairwise correlations of per papillae per kidney mean scores for the four components of the PPLA were determined. Mean PPLA scores for kidneys whose stones were majority (40-60% or more) apatite (group CaP) were compared to pure calcium oxalate stones and mixed calcium oxalate and apatite stones with less than 40% apatite (group CaOx). Statistical tests performed included Pearson correlation, Fisher's exact and ANOVA.

Results:

There were no differences in baseline characteristics between groups. From PPLA correlation analysis, pitting was positively related to Randall's plaque ($r=0.39$, $p=0.004$), while plugging was negatively correlated to Randall's plaque ($r=-0.5$, $p=0.0002$). Plugging positively correlated with loss of contour ($r=0.5$, $p=0.0003$). In total, 15 out of 56 (27%) kidneys were majority apatite stones. CaP had higher mean plugging scores compared to CaOx (1.35 vs. 0.78, $p=0.009$). CaOx had higher mean plaque scores compared to CaP (0.77 vs. 0.39, $p=0.04$). There were no differences in mean kidney pitting or loss of contour scores between groups.

Conclusions:

There appears to be two distinct stone formation pathways that are endoscopically identifiable given the positive and negative correlations of pitting and plugging to Randall's plaque, respectively. Further supporting this are the different stone types associated with plugging (CaP) and Randall's plaque (CaOx). Further studies are needed to determine if the association of plugging to loss of contour has clinical implications on renal function or other clinical parameters.

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Introduction

•The PPLA Grading System was recently introduced as a standardized way to describe renal papillae during endoscopic procedures.¹

•See PPLA details (center/top).¹⁻²

Objective

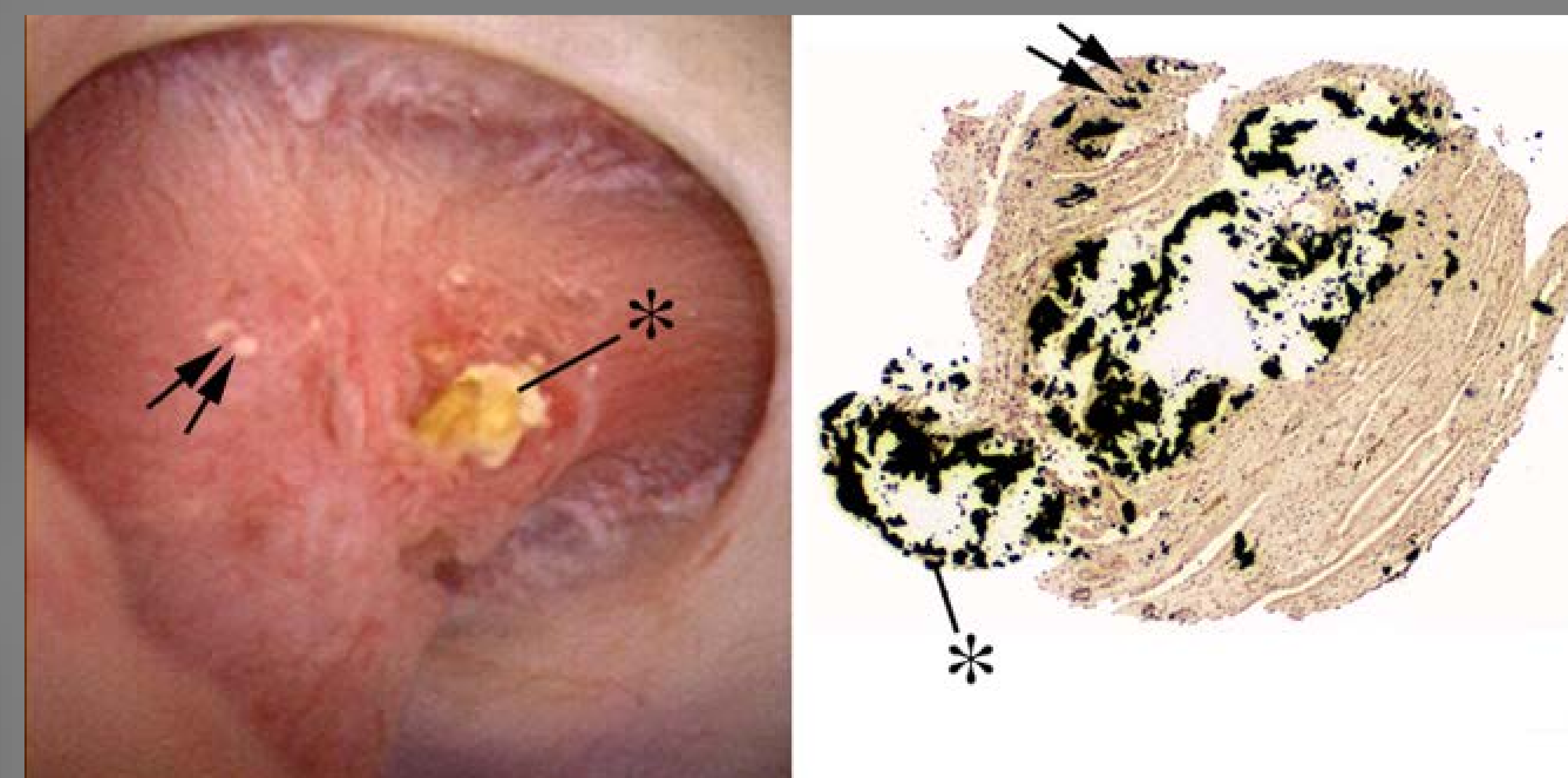
•In this study, we sought to compare PPLA scores to stone analysis to determine if endoscopic findings can predict stone type and if any insights to stone pathogenesis can be established.

Score	0	1	2
Plugging	0 yellow mineral deposits/dilated ducts	≤5 yellow mineral deposits/dilated ducts	>5 yellow mineral deposits/dilated ducts
Pitting	None	≤25% papillary surface	>25% papillary surface
Loss of Contour	None	Depressed	Completely flattened
Randall's Plaque	Mild	Moderate	Severe
Final PPLA Score	Sum of all scores		

Methods

- From an IRB-approved, single institution prospective database, 45 kidneys of calcium stone formers had undergone endoscopic mapping and PPLA grading from 2015-2016 at time of PCNL.
- Stone type was determined by micro-CT and IR spectroscopy:
 - Micro-CT: to determine % volume of stone composition
 - IR spectroscopy: to confirm specific minerals present
- Mean PPLA scores per kidney compared between:
 - Group CaP: majority apatite stones
 - Group CaOx: majority calcium oxalate
- Brushite stone formers were excluded.
- Statistical tests performed included Pearson correlation and ANOVA.

	CaOx	CaP	p (ANOVA)
Plugging	0.76	1.35	0.007
Pitting	0.70	0.87	0.3
Loss of Contour	0.57	0.60	0.8
Randall's Plaque	0.79	0.39	0.03



Results

•From PPLA correlation analysis:

- Pitting was positively related to Randall's plaque ($r=0.39$, $p=0.004$)
- Plugging was negatively correlated to Randall's plaque ($r=-0.5$, $p=0.0002$).
- Plugging positively correlated with loss of contour ($r=0.5$, $p=0.0003$).
- 15 out of 45 (33%) kidneys had majority apatite stones.
- 30 out of 45 (67%) kidneys had majority calcium oxalate stones.
- **Table (center):**
 - CaP had higher mean plugging scores compared to CaOx (1.35 vs. 0.76, $p=0.007$).
 - CaOx approached higher mean plaque scores compared to CaP (0.79 vs. 0.39, $p=0.03$).
 - There were no differences in mean kidney pitting or loss of contour scores between groups.

Discussion

- From PPLA, our data confirm significant correlations between pitting/plaque and plugging/loss of contour.
- Additionally, a negative correlation between plugging and plaque was identified which suggests these are distinct areas of PPLA.
- We hypothesized that two different pathways of stone formation, growth on Randall's plaque vs. on ductal plugs, leads to different stone types, CaOx vs. CaP.
- CaP stone formers were found to have higher plugging scores.
- CaOx stone formers were found to have higher plaque scores.
- Further studies with larger numbers of patients are needed to confirm or refute these results.
- We have observed that in patients who have severe plugging there is significant inflammation, fibrosis and loss of tubular epithelium.
- Possible proof of this observation is the association of loss of contour with plugging which may support the hypothesis that severe plugging could lead to renal function changes, see Picture – center/bottom.³

Conclusions

- From PPLA, pitting correlates with plaque while plugging correlates with loss of contour.
- Plugging is negatively correlated to plaque, indicating two separate pathways for stone formation.
- Calcium stone formers who have high amounts of plugging are more likely to form apatite stones, while those with increased plaque are more likely to make calcium oxalate stones.

References

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